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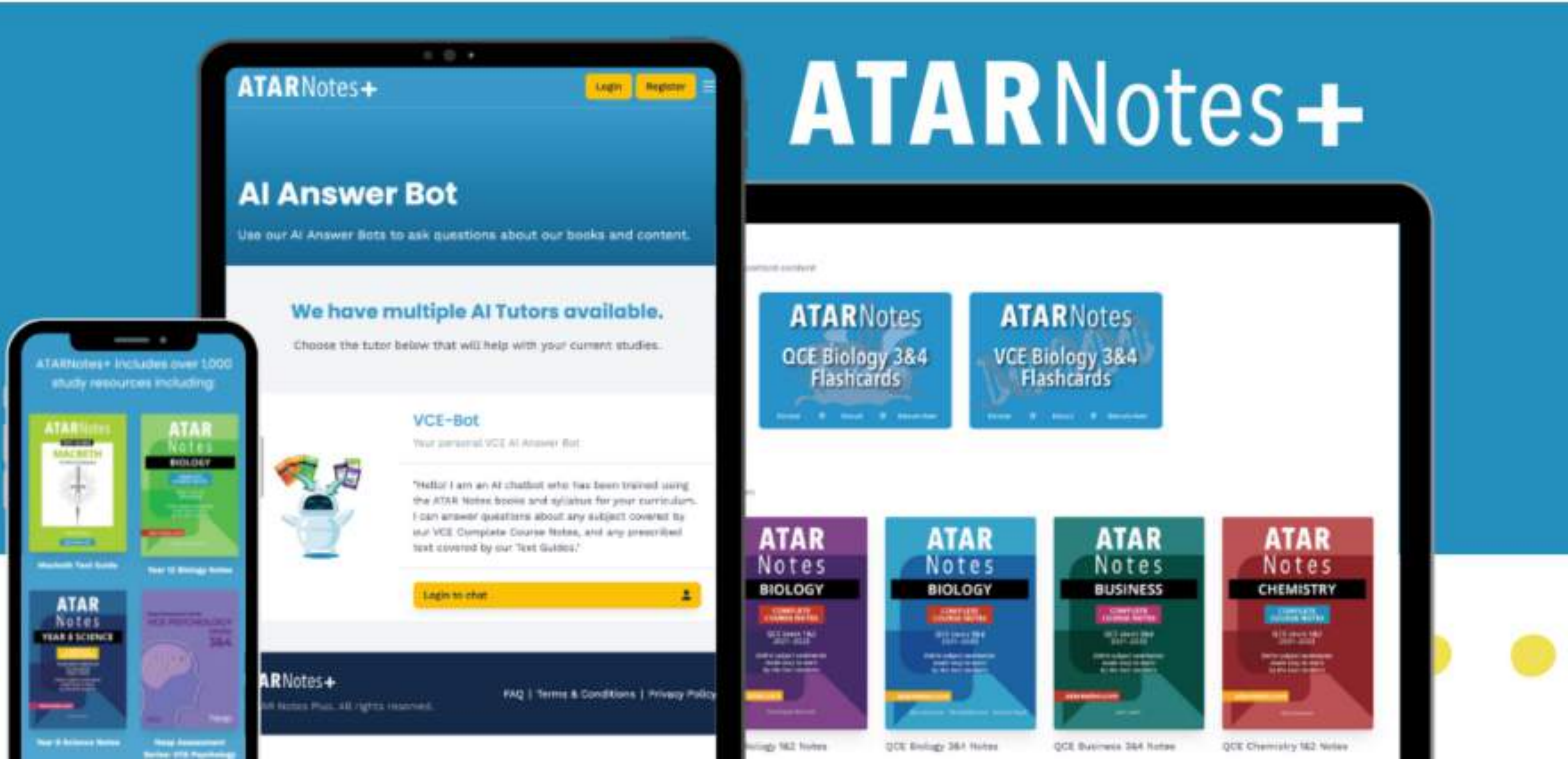


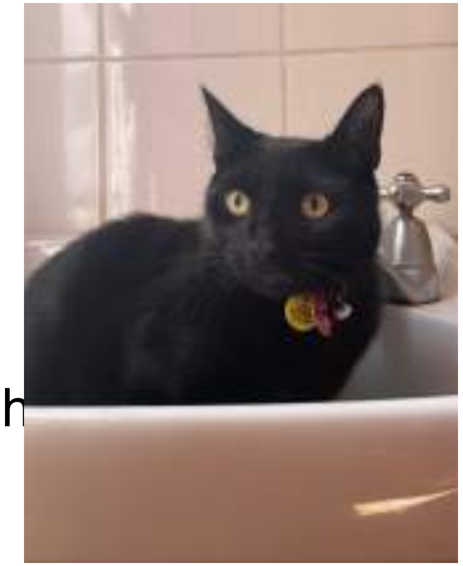
ATARNotes

VCE PE 3&4

ATARNotes January Lecture Series

Presented by:
Angelica

Overview



About me:

Hey ! I’m Angelica.

- Graduated in 2019 with a 97.25 ATAR
- 49 Biology, 40 PE and 47 English
- Graduated biomed, now doing medicine at Monash
- Tutor Biology, PE and English at TuteSmart
- Love: my cats and dog, long-distance running

Overview

- Going through each area of study
- Revising tips and advice for each area of study
- Ask questions throughout and I will answer in the live chat ☺

Overview

Unit 3

- Movement Skills
- Coaching, Practice and Feedback
- Biomechanics
- Energy Systems
- Acute Responses

Unit 4

- Activity Analysis
- Fitness Components
- Fitness Testing
- Training Methods + Principles
- Psychological + Nutritional Strategies
- Chronic Adaptations

Movement Skills

- *Classification of movement skills including fundamental movement skills, sport specific skills, open and closed skills, gross and fine skills, and discrete, serial and continuous motor skills (VCAA 2017)*

Fundamental movement skills are basic skills that then allow individuals to develop **sport-specific skills**. Fundamental movements skills include things such as walking, running and throwing and catching a ball.

Open motor skills are skills performed in an unpredictable environment (e.g. rafting). **Closed motor skills** are skills performed in predictable environments (e.g. platform diving).

Gross motor skills involve the use of large muscle groups (e.g. running). **Fine motor skills** involve the use of smaller muscles or muscle groups, and are used for precise movements (e.g. darts).

A **discrete motor skill** has a clear beginning and end (e.g. throwing a ball). **Serial motor skills** are combinations of discrete motor skills performed together (e.g. a gymnastics routine). **Continuous motor skills** have no clear beginning or end point (e.g. running).

Movement Skills

- *Influences on movement including individual, task and environmental constraints on motor skill development (VCAA 2017)*

Any factor that affects an individual's ability to learn and perform a skill is called a **constraint**. These can be broken into three categories:

Individual Constraints
- Body shape and size
- Fitness level
- Mental skills

Task Constraints
- Rules of the sport
- Resources and equipment available
- Team size/number of players

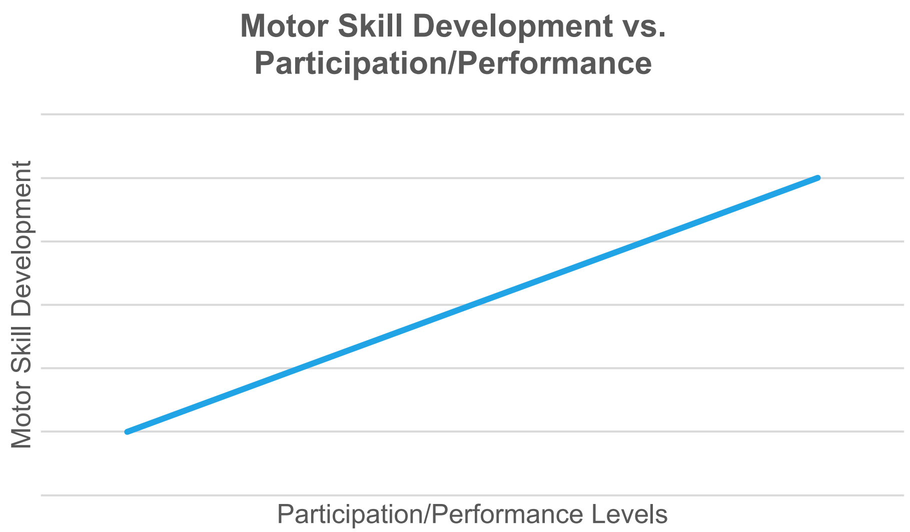
Environmental Constraints
- Physical environment (e.g. parks, ovals etc.)
- Weather
- Societal norms (e.g. Vic = Aussie Rules, NSW = rugby)
- Coaching available
- Support from family and friends

Movement Skills

- *The link between motor skill development and participation and performance (VCAA 2017)*

Basically, reduced motor skill development will lead to decreased participation and performance in physical activity.

If a child doesn't develop fundamental motor skills, such as running, jumping, balancing, catching and throwing, they are less likely to participate in physical activity. They are also less likely to successfully develop sport-specific motor skills, meaning that their performance in sports will be decreased.



Movement Skills

- *Qualitative movement analysis principles (preparation, observation, evaluation and error correction)*

QMA is used to assess human movement. The idea is then to use the assessment to improve the movement in some way, ultimately increasing performance in a particular sport.

Qualitative movement analysis may be used by coaches and teachers (among others) to help identify strengths and weaknesses of players, and also predict their potential.

Four Principles:

Preparation

This involves the observer (e.g. a coach) having a strategy for their observation. This involves have a specific reason for performing the analysis, and having a strong knowledge of the sport. They also need to decide if they will use technology, and if the observation has a particular focus.

Observation

This involves watching the player or team, and may be performed live or digitally. A key issue with this can be subjectivity – multiple observers may watch the same performance and have very different opinions about it.

Movement Skills

Evaluation

Also called ‘diagnosis’. Basically, evaluation involves judging the quality of the performance that was observed. In a QMA, this generally involves identifying an issue with performance, determining what is causing the issue and how the issue could be resolved.

During this stage, checklists and rating scales can be used to try to increase objectivity.

Validity: whether a test/method actually measures what it claims to measure. **Reliability:** whether a test/method produces consistent results.

Inter-rater reliability refers to the degree of agreement amongst different observers. This can be increased by having observers undertake similar training, and use the same scoring system. **Intra-rater reliability** refers to the consistency of scores giving by the same assessor.

Error Correction

As the name suggests, this stage (AKA intervention) involves trying to fix any mistakes observed during the earlier stages. For example, during half-time of a football match, when a coach addresses his team, he is trying to fix potential issues that he observed, using qualitative movement analysis.

Movement Skills

- *Sociocultural factors that have an effect on skill development, and the characteristics of the three stages of learning (cognitive, associative and autonomous) (VCAA 2017)*

Sociocultural factors influence skill development at all three stages of learning. Examples of sociocultural factors include:

- Time
- Self-belief
- Role models
- Religion
- Personality
- Family dynamics
- Resources

Stages of Learning

Cognitive (Beginner)

In this stage, learners are often trying to work out what skills they actually need to perform. Their performance will be inconsistent and of a lower level, and they will generally ask lots of questions.

Simple instructions and lots of visual demonstrations are really important, as well as consistent positive feedback.

Movement Skills

Associative (Intermediate)
In this stage of learning, the individual will become more consistent and continue to refine their technique. Improvements are generally more gradual, and lots of practice will be performed. Practice should start to become more varied and unpredictable.

Autonomous (Advanced)
In this stage, motor skills become automatic. This results in performance being at a very high level and being very consistent. Practice in this stage should be highly unpredictable and varied – simulating game-like conditions as much as possible.

The impact of sociocultural factors can vary depending on the stage of learning (example below):

Sociocultural Factor	Cognitive Stage	Associative Stage	Autonomous Stage
Family Dynamics	Having parents and siblings that encourage playing sport, and can play as well, is important for interest and skill development.	Often, it is important that family members are able to provide transport to training or matches, and/or provide someone to practice with.	Family dynamics are unlikely to be overly important in this stage.

Coaching

- *Direct and constraints based approaches to coaching and instruction (VCAA 2017)*

We look at two styles of coaching – direct coaching and constraint-based coaching.

Direct Coaching
This is more of an 'old-school' style of coaching. Generally, when using direct coaching, the learner doesn't have to do much thinking for themselves or make decisions. The coach decides what task are going to be completed, how long will be spent on each task and in what order.
E.g. Doing 50 tennis serves in a row

Constraint-Based Coaching
Constraint-based coaching is much more adaptive than direct coaching, and modifies tasks due to individual, environmental and task constraints. Coaches guide training, rather than run it.

Learners perform tasks in their own ways suited to their strengths and weaknesses, and are much more independent and able to make decisions. Often practices are highly variable with lots of different tasks being performed. Constraints are often modified (e.g. changing the rules of a practice game, such as half-court tennis) to try and increase the learning of a skill.

Coaching

- *Practice strategies to improve movement skills including amount, distribution (massed and distributed) and variability (blocked and random) (VCAA 2017)*

Amount of Practice

Generally, more practice is better (be aware of fatigue). During the cognitive stage of learning, improvement occurs quickly, while in the associative & autonomous stages, improvement is more gradual.

Distribution of Practice

Distributed practice involves shorter, more frequent training sessions. This is believed to be better for learning and is used at the elite level.
Massed practice involves longer, less frequent training sessions. This is more likely to result in fatigue, and is generally used at local/amateur level.

Variability of Practice

Blocked practice involves practicing the same skill repeatedly for a period of time without performing any other skills. Often suitable for beginners, who are still learning the motor skill.
Random practice is performing a number of different skills together. This is better suited to learners in the associative and autonomous stages, and is believed to increase the learning of skills.

Coaching

- *Feedback including type (intrinsic, augmented, knowledge of results and knowledge of performance) and frequency (VCAA, 2017)*

Feedback is any sort of information that an individual gathers or receives about their performance on a specific task.

Intrinsic feedback is when the individual uses their own senses to judge their performance. E, a cricket players may feel the ball come off the middle of the bat and see it race away to the boundary.

Augmented feedback is external feedback. This generally comes from someone like a coach.

Augmented feedback can be split into two categories - knowledge of results and knowledge of performance.

Knowledge of results refers to feedback about the outcome of a particular task. For example, for a player trying to learn to pitch accurately in baseball, the coach could give feedback on how close they were to a target.

Knowledge of performance refers to the characteristics of a task, rather than the specific outcome of the task. For example, a coach may tell their pitcher to follow through more on their pitch.

Coaching

Frequency of Feedback

For learners in the cognitive (beginner) stage, they will need a lot of feedback. This is because they probably won't be able to identify their own errors and correct them.

As learners move into the associative and autonomous stages, less feedback is needed as athletes are able to identify and correct their own errors a lot more.

Basically, as athletes move through the stages of learning, less feedback is needed.

Movement Skills

- Be able to identify the different types of skills. Know a couple of simple examples for each category that you can easily name
- Know the steps of qualitative movement analysis, and you can generally think about each step fairly logically (as to what it actually involves)
- Be able to identify how different factors affect different stages of learning – might be how VCAA make that area a bit more difficult
- Practice using scenarios, and identify the type of coaching and practice/feedback that is happening
- Be aware of the advantages and disadvantages of each type of coaching and practice methods

Biomechanics

- *Biomechanical principles for analysis of human movement including:*

– angular and linear kinetic concepts of human movement: Newton's three laws of motion, inertia, mass, force, momentum and impulse (VCAA 2017)

Biomechanics involves studying living things from a mechanical perspective. This includes using physics, such as measuring different forces, to improve human movement.

Note that you don't have to actually perform calculations in the PE exam (you don't get a calculator) – you just have to have a theoretical understanding of the different concepts involved in biomechanics.

Forces

Forces are when one object acts on another object (an easy way to think about it is a push or a pull). Forces are measured in Newtons (N).

Forces will generally change the motion of an object – either speeding it up, slowing it down or changing its direction.

Biomechanics

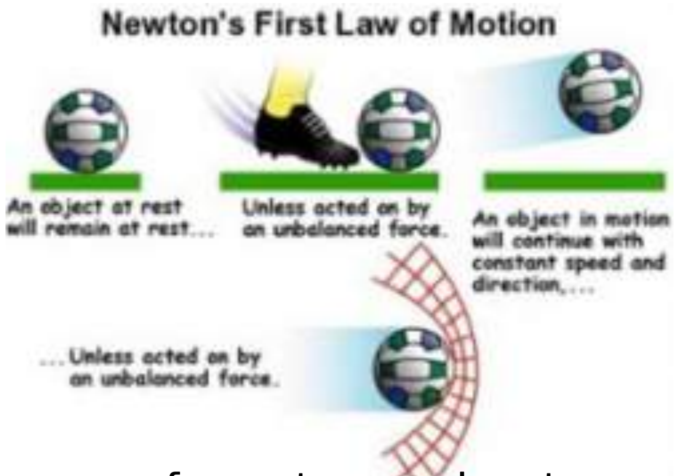
Mass and Weight

Mass is measured in kilograms. For example, I have a body mass of about 65kg.
Weight is the force acting on an object due to gravity, and is measured in newtons (N). Weight = mass x gravity.

Newton's Three Laws of Motion

Newton's First Law

'An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force'. This is also known as the law of inertia.



Newton's Second Law

'Force = mass x acceleration'. (Commonly written as f = ma). Bigger mass = more force to accelerate.

Newton's Third Law

'For every action there is an equal and opposite reaction'. Not always easy to see. Think about a tennis ball hitting a racquet. The racquet has an impact on the ball, and the ball will have an equal reaction (same force) on the racquet.

Biomechanics

Inertia

Inertia is the tendency for an object to resist any change to its state of motion. Basically, if an object is at rest, it will stay at rest, and if it is moving, it will keep moving (unless acted upon by an unbalanced force). Higher mass = higher inertia (100kg weight vs 2kg weight).

Momentum

Momentum is the 'amount of motion' that a moving object has (it is a bit tricky to define).

Momentum = mass x velocity. This is often written as $p = mv$. Momentum is measured in kg m/s.

Imagine two objects that have the same velocity – the one with the greater mass will have the most momentum. It's the same if two objects have the same mass – the one with the greatest velocity will have the most momentum.

<u>Conservation of Momentum</u>

In an isolated collision (which is where there are no external forces acting), momentum will always be conserved.

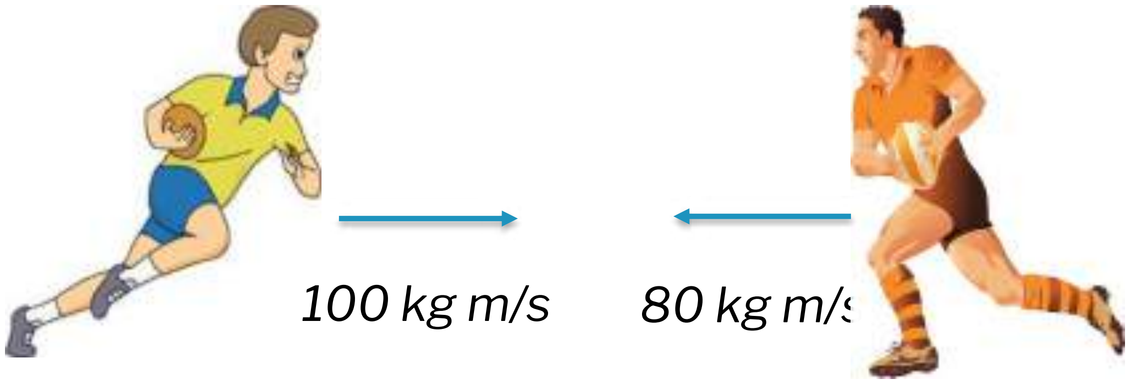
What this means is that the *total net momentum* before the collision is equal to the *total net momentum* after the collision.

Momentum (cont.)

<u>Conservation of Momentum</u>

What is net momentum? Let's look at an example:

The player on the left has a momentum of 100 kg m/s, and the player on the right has a momentum of 80kg m/s.



Net momentum = 100 - 80 = 20kg m/s to the right.

So the net momentum before the collision is 20kg m/s to the right. This means that the total net momentum after the collision also has to be 20kg m/s to the right.

The key point is that if two objects going in different directions collide, the two objects will move off together in the direction of the object that had the greatest momentum was travelling.

Biomechanics

Momentum (cont.)

Summation of Momentum

The summation of momentum refers to an object being struck with maximal velocity, when the object is to hit it as far as possible. Momentum is generated through the body in a sequential fashion, beginning with body parts closest to the centre of gravity (e.g chest) and then transferred to the parts of the body further away (e.g. wrist).

Impulse

Impulse is the change in momentum of an object. To change momentum, a force needs to be applied to an object over a period of time. Impulse = force x time.

Imagine when you are catching a ball that is coming at you quite quickly. When you catch it, you naturally move your hands backwards to 'cushion' the ball. What this is doing is increasing the time over which the force is applied, which therefore decreases the force of the ball on your hands.

Mountain climbers use nylon ropes to increase the stopping time and decrease the stopping force.

Biomechanics

So far we've looked at linear (straight line) motion. Now we're going to look at angular motion.

Newton's Laws of Angular Motion

<u>Newton's First Law</u>

'The angular momentum of an object will remain constant unless acted upon by an external torque'.

A **torque** is simply a rotational force (think of it as a twist!).

<u>Newton's Second Law</u>

'A torque applied to an object will cause a change in the angular motion of the object that is proportional to the size of the torque, and inversely proportional to the moment of inertia that the object has'.

The **moment of inertia** is the tendency of an object to resist changes to its rotation.

$$Moment\ of\ inertia = mass \times radius^2$$

An object whose mass is close to the centre will be much easier to rotate (as it has a lower moment of inertia) than an object whose mass is spread far away from the centre. This is why junior players often use smaller equipment (e.g. cricket bats, golf clubs, tennis racquets) as they are easier to rotate due to their lower moment of inertia.

Biomechanics

Newton's Laws of Angular Motion (cont.)

Newton's Third Law

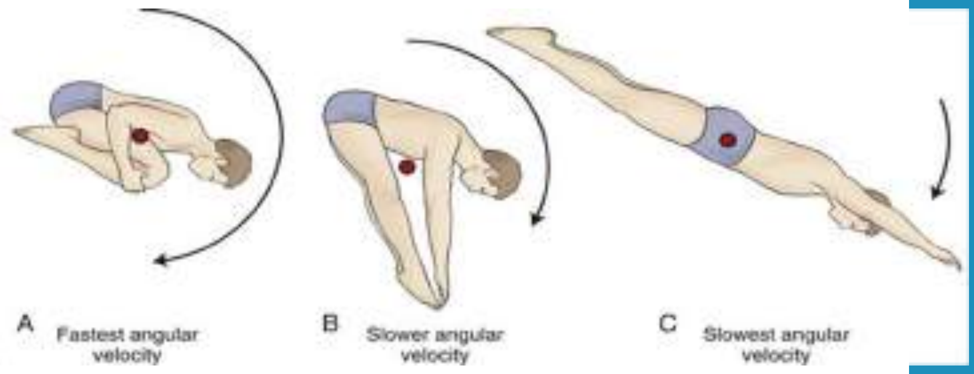
'For every torque, there is an equal and opposite torque'.

Angular Momentum

Angular momentum is the 'amount of angular motion' that an object has. It is always conserved.

$$Angular\ momentum = moment\ of\ inertia\ \times angular\ velocity$$

Why does a diver go into the tuck position to perform a triple somersault?



Angular momentum is conserved while an object is in flight. This means that when a diver goes into a tuck position, their moment of inertia is decreased, because their mass is closer to the centre. This means that their angular velocity must be increased, as angular momentum remains the same. This allows the diver to somersault more quickly, and potentially perform more flips while in the air.

Biomechanics

- *Biomechanical principles for analysis of human movement including:*

– angular and linear kinematic concepts of human movement: distance, displacement, speed, velocity, acceleration and projectile motion (height, angle and speed of release) (VCAA 2017)

<u>Distance and Displacement</u>

Distance measures how far an object has travelled, following the path that the object has taken.

Displacement measures the change in position of an object from its starting position to its end position. However, it does not follow the path that the object has taken – it goes in a straight line.

<u>Speed and Velocity</u>

Speed is equal to $\frac{distance}{time}$.

Velocity is equal to $\frac{displacement}{time}$. Velocity also has a direction, e.g. 10m/s north.

<u>Acceleration</u>

Acceleration is a change in velocity over a period of time. Zero acceleration does not mean no movement!

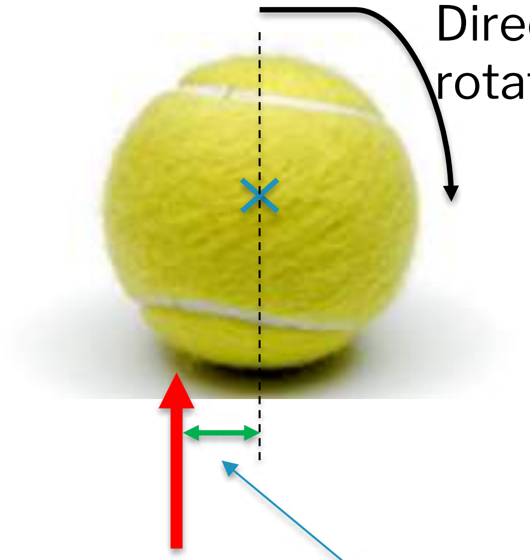
$$Acceleration = \frac{change\ in\ velocity}{change\ in\ time}$$

Biomechanics

Now we'll jump back into angular motion.

Angular motion is caused by an eccentric force acting on an object - a force that doesn't act through the centre of gravity of an object.

Say we have a circular ball, shown below:



If we have an eccentric force act on the bottom left of the ball here, this will cause it to rotate clockwise.

How much it rotates will depend on the size of the force, and the size of the lever arm. The lever arm is the perpendicular distance between where the force was applied and the centre of the ball.

The greater the lever arm, the greater the **torque,** or rotation of the ball.

Biomechanics

Angular Distance and Displacement

Angular distance and displacement works in a very similar way to linear distance and displacement.
Imagine a gymnast swinging around a bar. If the gymnast does two full rotations, then their angular distance will be $2 \times 360^0 = 720^0$. However, their displacement will be zero degrees, as their starting position is the same as their final position.

Angular Speed and Velocity

Angular speed is the total distance covered divided by the total time taken.
Angular velocity is the change in displacement over time.

$$Linear\ velocity = angular\ velocity \times radius\ of\ rotation$$

Imagine a golfer hitting a ball. To increase the linear velocity of the ball, they could increase their radius of rotation (size of the club). This explains why drivers are longer than irons.

Angular Acceleration

Angular acceleration is the rate of change of angular velocity, and works in the same way as linear acceleration.

Biomechanics

Projectile Motion

Any object that is thrown or struck into the air is a projectile. We break down projectile motion into two components – a vertical component and a horizontal component.

Vertical Component

The vertical component of a projectile (which is usually how high it is off the ground) is influenced by gravity. Any projectile in the air is acted upon by gravity, and therefore has an acceleration of 9.8m/s towards the ground.

Horizontal Component

The horizontal component affects how far the ball travels before hitting the ground (usually). This is affected by air resistance – if there was no air resistance, horizontal velocity would remain continuous.

Factors that Affect Projectile Motion

Angle of Release

The angle of release is the angle that the projectile makes to the ground when it is released. Generally 45^{o} is the optimal angle for horizontal distance (more details on this on the next slide).

Speed of Release

A greater speed of release results in greater horizontal and vertical range.

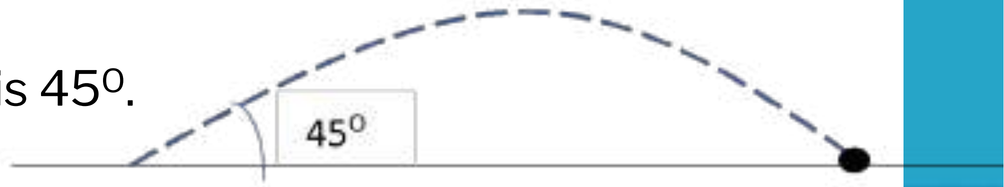
Biomechanics

Factors that Affect Projectile Motion (cont.)

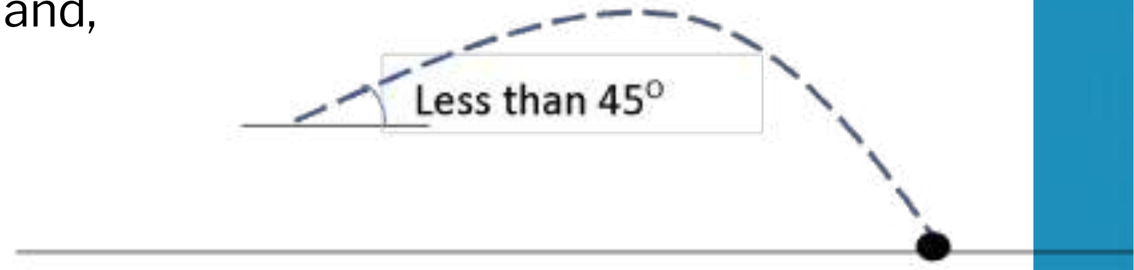
<u>Height of Release</u>

The height of release is the height from which the projectile is launched, in comparison to where it lands (or is stopped).

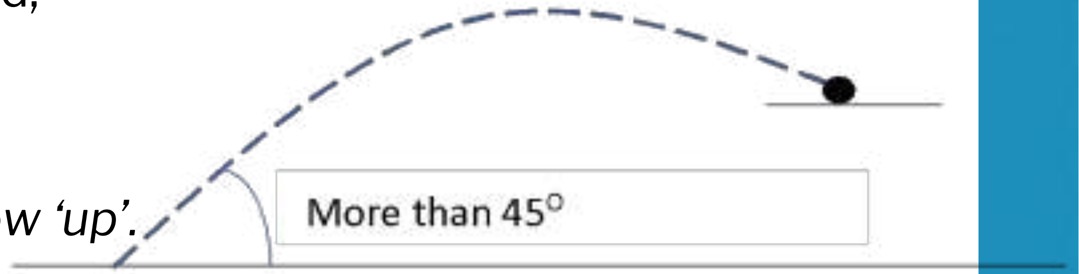
If the height of release is zero, then the optimal angle of release is 45^{o}.



If you are launching the projectile from above where it will land, then the optimal angle of release is less than 45^{o}.



If you are launching the projectile from below where it will land, then the optimal angle of release is more than 45^{o}.



One way to think about it – if you have to throw high, you throw ‘up’.

Biomechanics

- *Biomechanical principles for analysis of human movement including:*

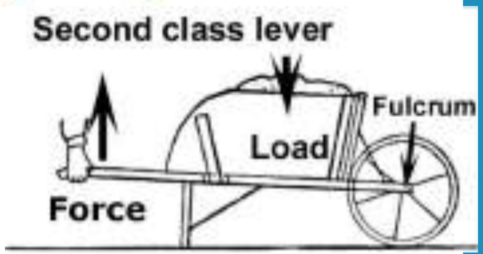
– equilibrium and human movement: levers (force, axis, resistance and the mechanical advantage of anatomical levers), stability and balance (centre of gravity, base of support and line of gravity) (VCAA 2017)

Levers

A lever is a rigid bar that rotates around an axis to exert a force on another object. All levers consist of an axis, a force and a resistance (or a weight to be shifted).

First-Class Levers

In a first-class lever, the force and resistance are on opposite sides of th

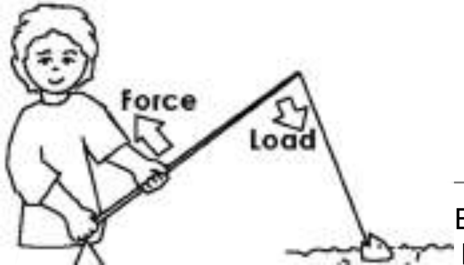


Second-Class Lever

In a second-class lever, the resistance is between the force and the axis.

Third-Class Lever

Third-class levers are when the force is between the resistance and the axis. These levers are quite common in the body. Any time you swing something in your hand, a third-class lever is generally being used.



Biomechanics

Levers

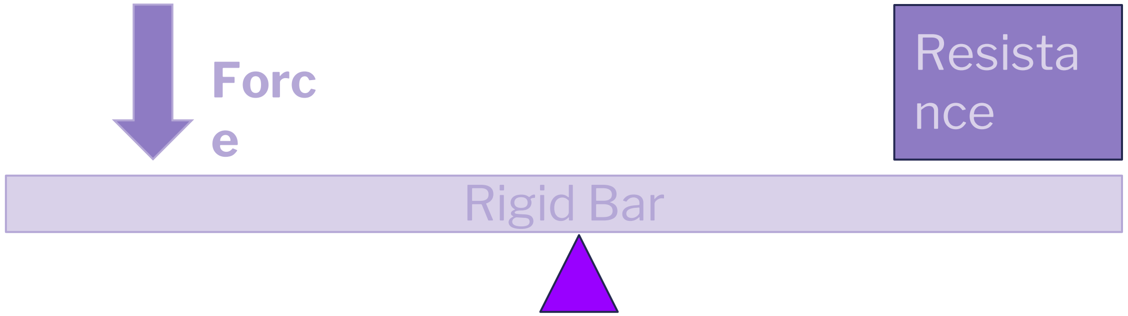
A lever is a **simple machine** consisting of **a rigid bar** that can **rotate around an axis** in order **to exert a force** on another object.

- **All levers have three parts:**

-An Axis or Fulcrum

-A Resistance or Load

-A Force or Effort

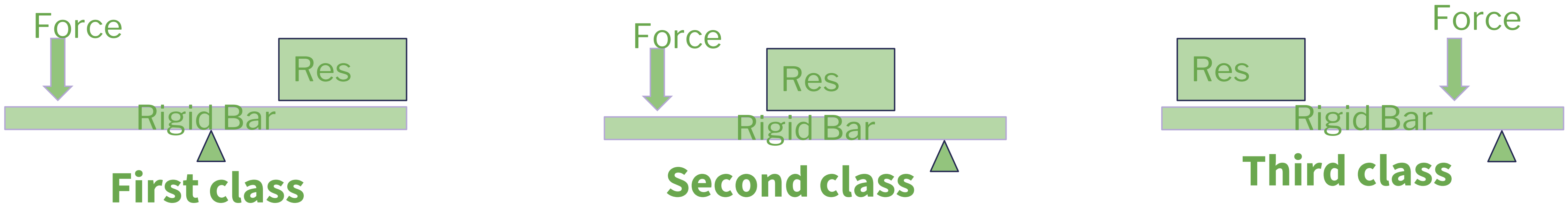


*Think of the resistance as a heavy load such as some heavy rocks or stones in a wheelbarrow, and the force as your own arms pushing down on the handles in order to move the rocks.

Biomechanics

Classification of Levers

-Levers are classified by the **position of the axis**, **resistance** and **force**.

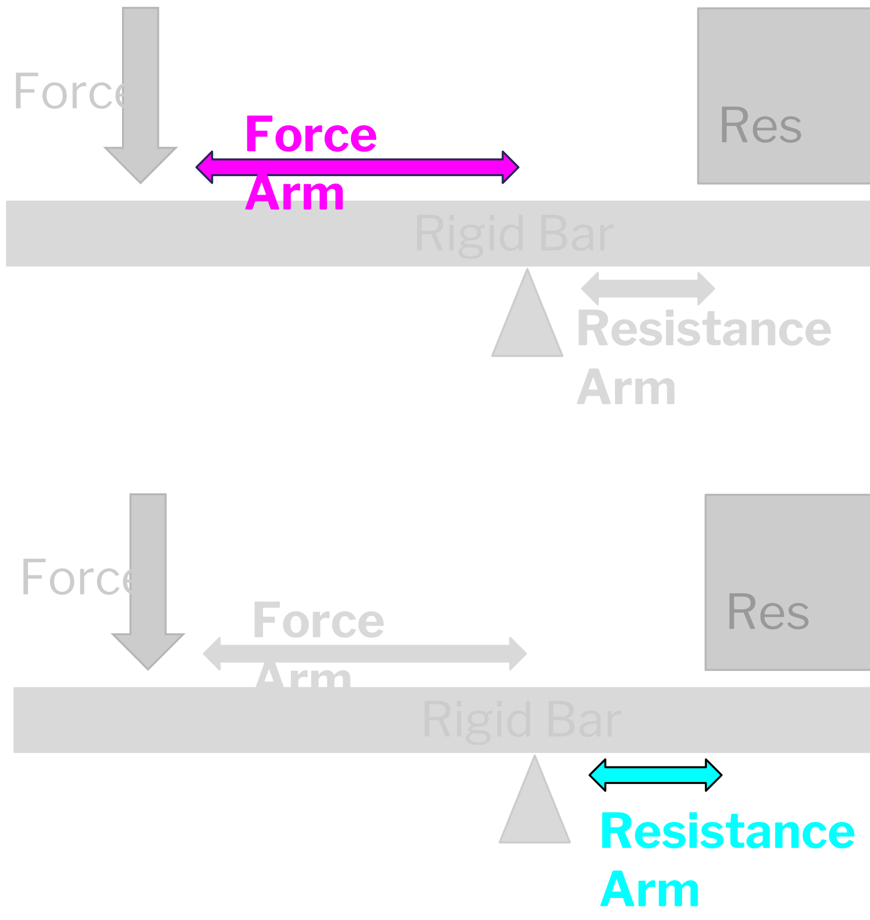


-There are **three types**: First class lever, second class lever and third class lever.

-The **difference** between them is the **position of the axis, resistance and force**.

-The most common types of levers found in the human body are third class levers.

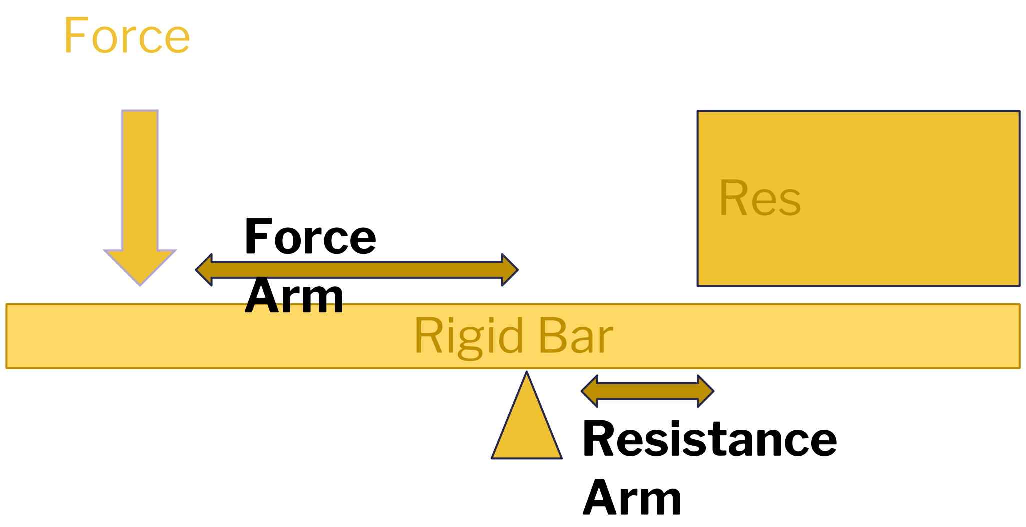
Biomechanics



- The **force arm** is the **horizontal distance** between the **fulcrum/axis** and the **force/effort.**

- The **resistance arm** is the **horizontal distance** between the **fulcrum/axis** and the **resistance/load.**

Biomechanics



Examples of first class levers in the human body:

The Human Head:
-Axis: Top of neck
-Force: Chin
-Resistance: Muscles in back of neck

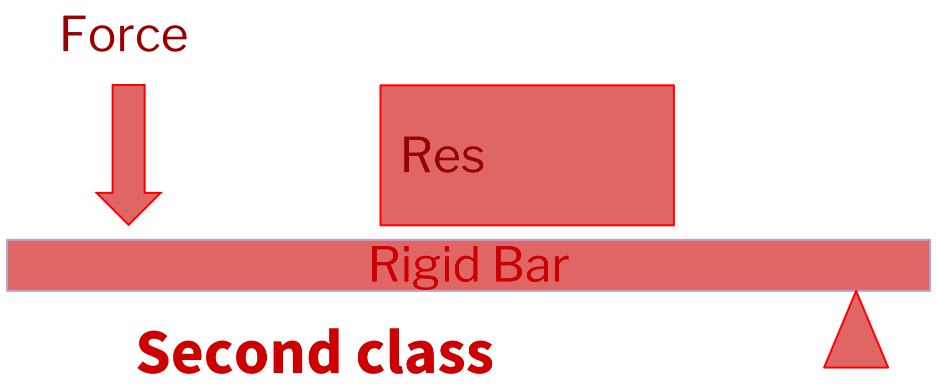
First Class Levers

-In a first class lever, the **axis lays between** the force and the resistance.

-In the human body, muscles work in pairs on opposite sides of a joint axis. This is an example of a first class lever.

-First class levers can be **manipulated** to **increase the force output** by increasing the distance from the axis to the force (i**ncreasing force arm**), increasing the **lever's range of motion** by increasing the **resistance arm**.

Biomechanics



Examples of second class levers in the human body:

Standing on tip-toes:
-Axis: Toes
-Force: In calf muscles
-Resistance: In arch of foot

Second Class Levers

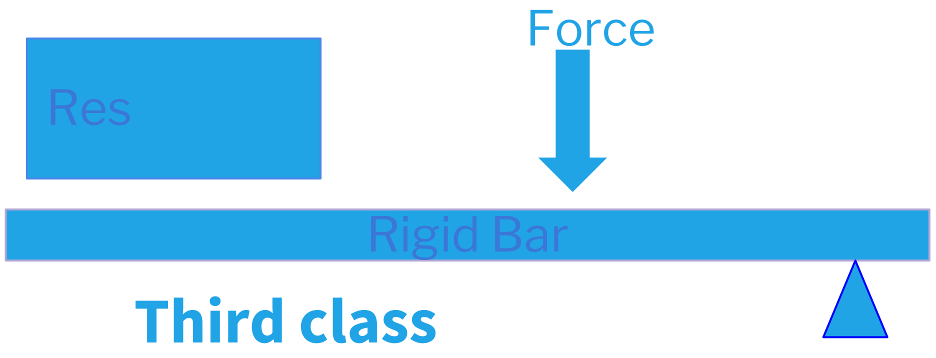
-In a second class lever, the **resistance is between** the axis and the force.

-As such, in second class levers, the **force arm is longer** than the resistance arm.

-Second class levers are designed to increase the mechanical advantage of levers (we will talk about this soon) and in doing so, **increase the force output**.

-They are **most useful for moving heavy loads**.

Biomechanics



Examples of second class levers in the human body:

Bicep Curl:
-Axis: Elbow
-Force: Biceps (in front of elbow)
-Resistance: The dumbbell or weight

Third Class Levers

-In a third class lever, the **force is between** the axis and the resistance.

-Therefore, in third class levers, the **resistance arm is longer** than the force arm.

-Third class levers require a greater force to be applied to move a given resistance, but have a greater range of motion and speed of motion.

-These are the most common type of lever in the human body and in sporting applications.

Biomechanics

Stability and Balance
Equilibrium, balance and stability mean similar, but slightly different things.

Equilibrium is when an object has no unbalanced forces acting on it. This means it has no acceleration.

Balance is the ability to control equilibrium.

Stability is the resistance to the loss of equilibrium. With a high level of stability, it is difficult to unbalance an object (e.g. a sumo wrestler).

For example, picture a sprinter in a 100m race. They have a force acting on them, so they are not in a state of equilibrium. They are purposefully controlling their balance to be able to move forward quickly, but they have a low level of stability (e.g. if someone bumps into them, they will likely fall over).

Biomechanics

Stability and Balance (cont.)

Factors Affecting Stability and Balance

Centre of Gravity

An individual's centre of gravity is the point around which their weight is balanced. The lower the centre of gravity, the more stable a person will be.

Base of Support

An individual's base of support is the area between their feet (or whatever part of them is touching the ground).
Generally, the larger a person's base of support, the more stable they w

Line of Gravity

Imagine the line of gravity as a line that runs from above you, through your centre of gravity and then hits the ground.
If this line falls within your base of support, then you will have an increased level of stability, and vice versa.

Biomechanics

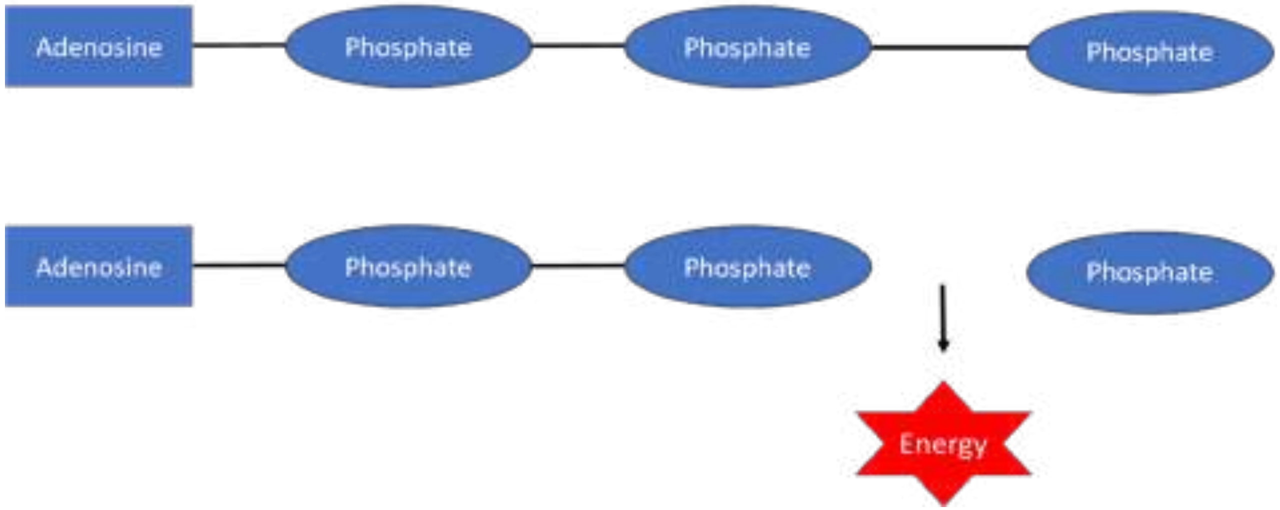
- DON'T PANIC!!
- Practice using questions as much as possible – see the VCAA exams
- Remember calculations aren't necessary – you just have to have a theoretical understanding
- I would work on having set (basically memorised) answers to common biomechanics questions that you see (e.g. why a gymnast might tuck while in the air?)
- Know the three different types of levers and memorise an easy example for each

Energy Systems

- *Fuels (both chemical and food) required for resynthesis of ATP at rest and during physical activity, including the relative contribution of fuels at varying exercise intensities (VCAA 2017)*

ATP

Adenosine Triphosphate (ATP) is the only source of energy for muscular contraction. Other fuels that we look at, such as glycogen and triglycerides, simply allow ATP to be rebuilt from ADP.



When one of the phosphate molecules ‘breaks away’, energy is produced that is used for muscular contraction.

Energy Systems

Fuels

Each of the three energy systems (we'll go through them in a moment) requires some sort of fuel to produce ATP.

<u>Phosphocreatine</u>

Phosphocreatine (PC) is a chemical fuel used by the ATP-PC system. Around 10 seconds worth of phosphocreatine can be stored at the muscles.

<u>Carbohydrates</u>

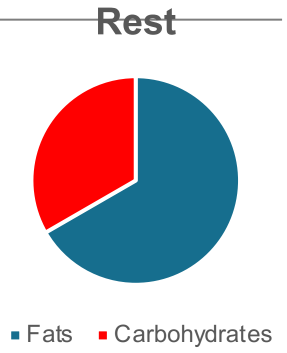
Carbohydrates are the body's preferred fuel during exercise. They are broken down and stored as glycogen or glucose. Carbohydrates are the preferred fuel source over fats because they take less oxygen to produce the same amount of energy, in comparison to fats.

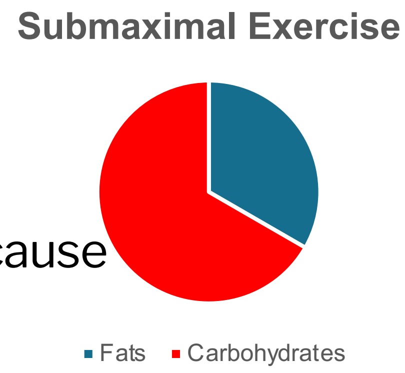
<u>Fats</u>

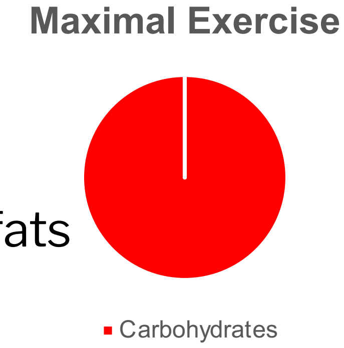
Fats are the body's preferred fuel at rest. They are stored as triglycerides.

<u>Protein</u>

Protein is only used as a fuel for energy production in extreme circumstances, when both fats and carb stores have been depleted.







Energy Systems

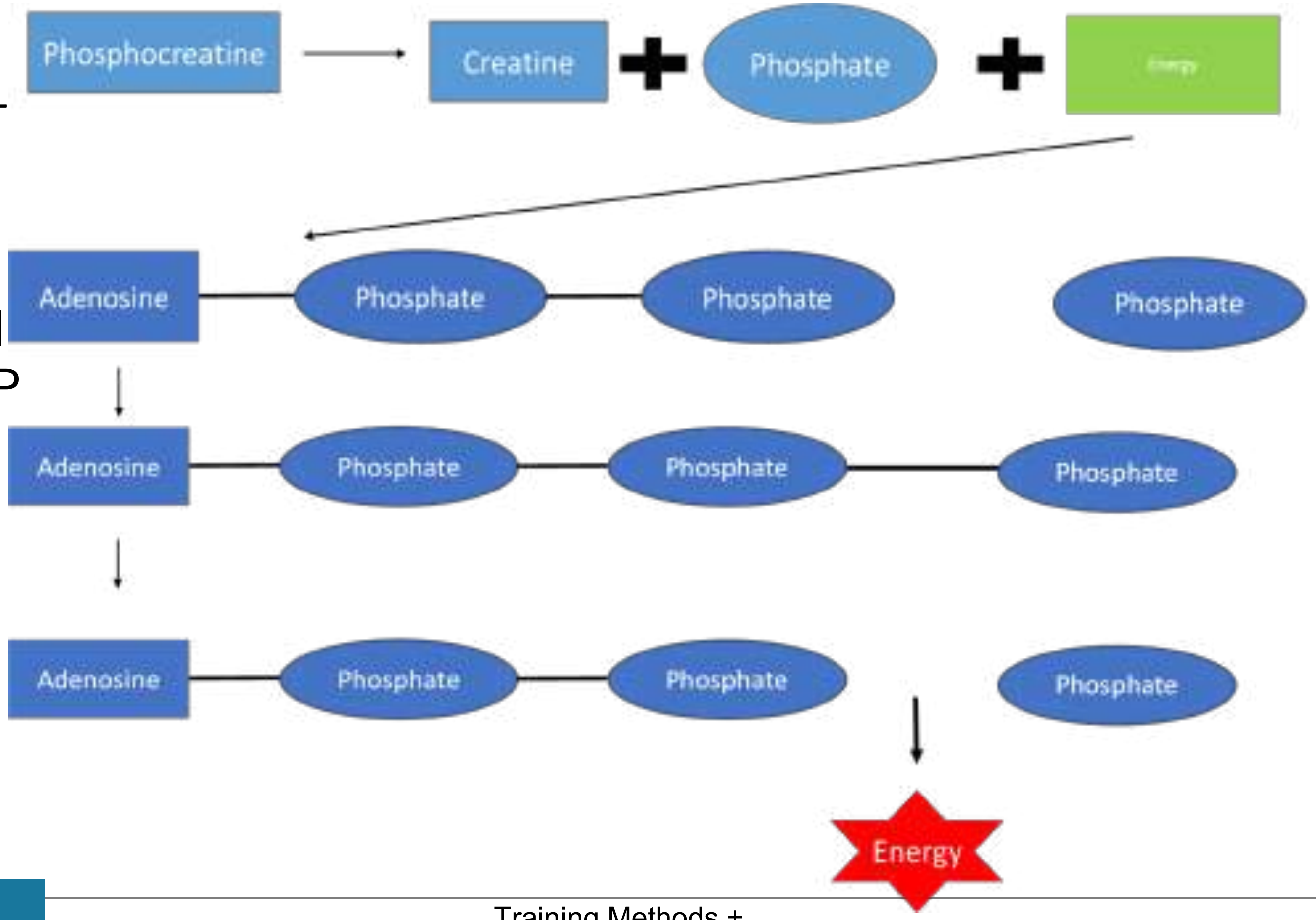
Characteristics of the three energy systems (ATP–CP, anaerobic glycolysis, aerobic system) for physical activity, including rate of ATP production, the yield of each energy system, fatigue/limiting factors & recovery rates associated with active and passive recoveries (VCAA 2017)

ATP-PC System

The ATP-PC system (also known as the ATP-CP system) is an anaerobic energy system that uses phosphocreatine (PC) as fuel.

When PC is broken down into phosphate and creatine, this produces energy that allow ADP to be rebuilt into ATP, giving it the potential to produce energy for movement again.

The ATP-PC system produces a very small amount of ATP at a very fast rate. It is used for high intensity activities of a very short duration (10 seconds or less).

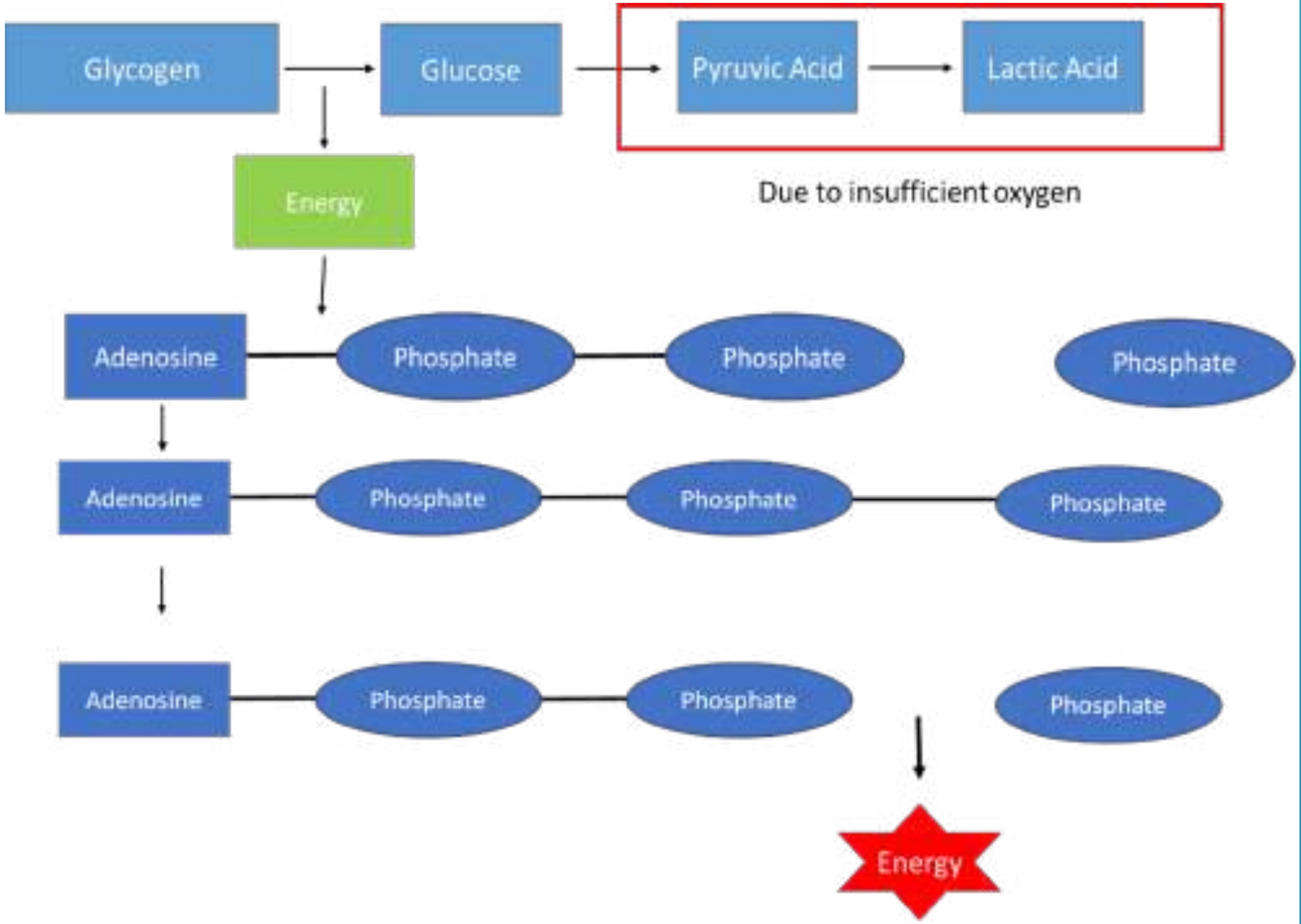


Energy Systems

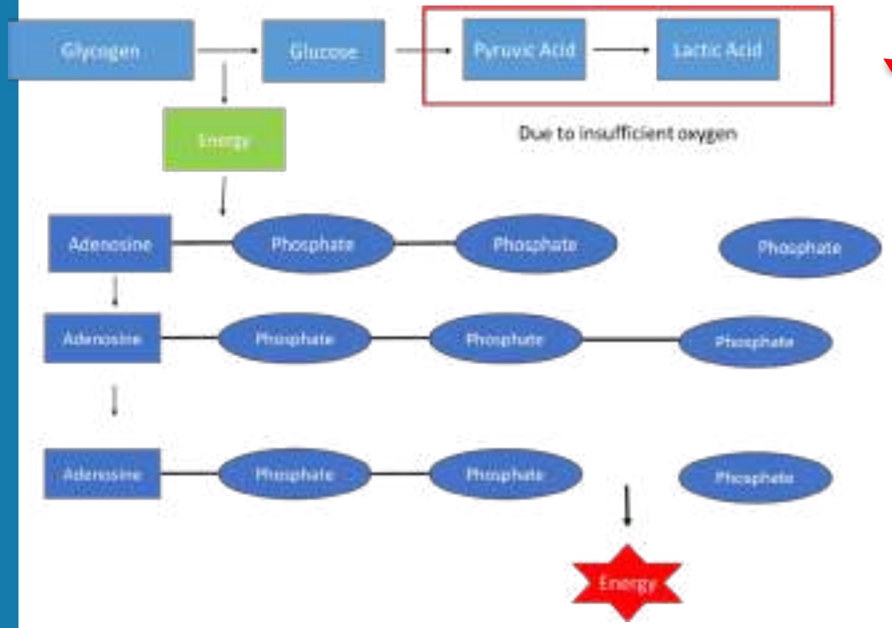
Anaerobic Glycolysis System
The anaerobic glycolysis system uses carbohydrates as its fuel.

Glycogen is broken down into glucose, which provides the energy necessary to rebuild ADP into ATP (similar to the ATP-PC system, except it uses PC instead of glycogen).

The anaerobic glycolysis system produces energy at a slower rate than the ATP-PC system, but it produces more ATP.



Energy Systems

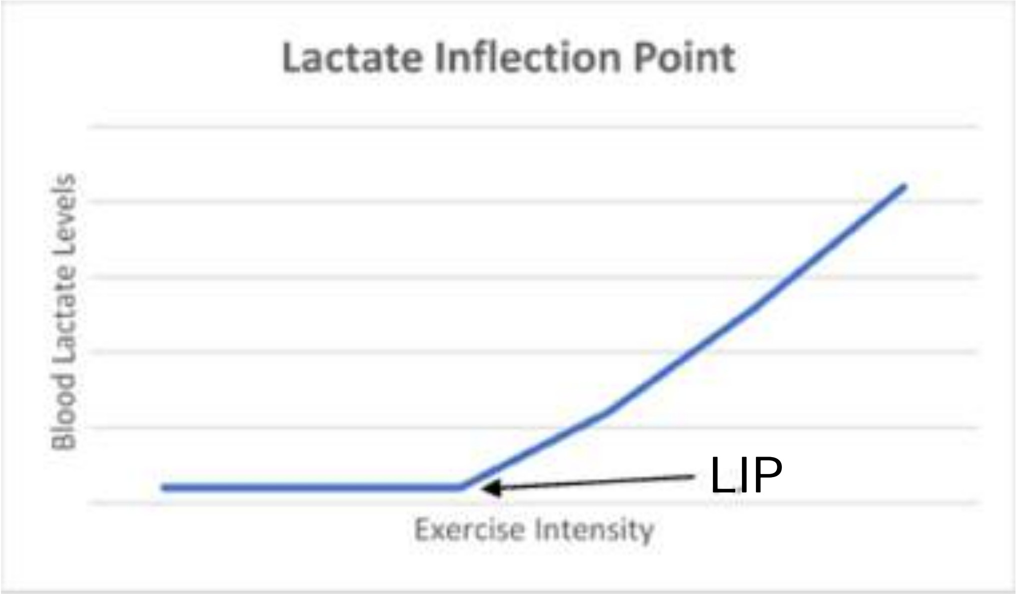


Anaerobic Glycolysis System (cont.)
A by-product of the breakdown of pyruvic acid into lactic acid is hydrogen ions (H^+ ions). This causes the muscle to become more acidic, which causes fatigue.

<u>Lactic acid doesn't cause fatigue – the accumulation of H^+ ions do.</u>

Lactate Inflection Point (LIP)
The lactate inflection point (LIP) refers to the last point where lactate entry into and removal from the blood are balanced.

After this point, lactate (and therefore H+ ions) will accumulate in the muscles & cause feelings of fatigue.

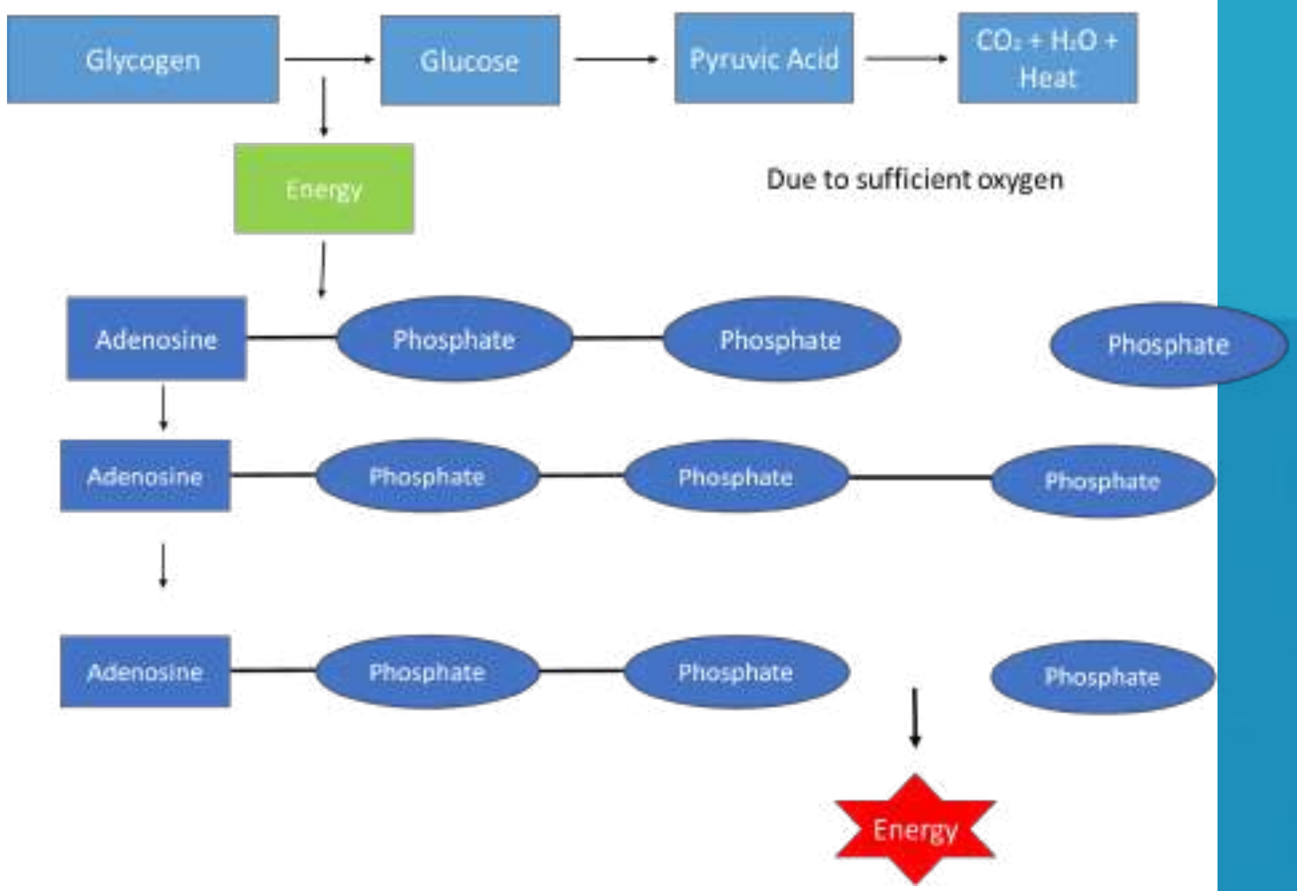


Energy Systems

Aerobic System
The aerobic energy system is the only energy system that requires oxygen. It uses carbohydrates (glycogen), fats (FFAs) or protein (in extreme cases) as fuels.

The aerobic energy system produces ATP at a very slow rate, but produces a far greater amount of ATP than both the ATP-PC system and the anaerobic glycolysis system.

It can be used indefinitely (e.g. during a marathon).



Energy Systems

	ATP-PC System	Anaerobic Glycolysis System	Aerobic Glycolysis System
Aerobic/Anaerobic	Anaerobic	Anaerobic	Aerobic
Fuel	Phosphocreatine (PC)	Glycogen	Glycogen FFAs Protein
Intensity	Very High (95%+ Max HR)	High (Greater than 85% max HR)	Submaximal (Less than 80% max HR)
Total Duration	10 seconds	75 seconds (roughly)	Indefinite
Peak Power	2-4 seconds	5-15 seconds	60-90 seconds
When system is dominant during physical activity	1-5 seconds	5-60 seconds	60 seconds +
By-Products Produced	Inorganic Phosphates (P_i) ADP	Lactic Acid H^+ Ions ADP	CO_2 H^2O Heat
Speed of ATP Production	Very fast (simple chemical reactions)	Fast	Slow
Amount of ATP Produced	0.7 per PC molecule	2-3 per Glycogen molecule	38 per Glycogen 441 per Triglyceride

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Energy Systems

Energy Systems and Fatigue

Fuel Depletion

For the ATP-PC system, fuel depletion refers to the depletion of ATP stored at the muscles (which takes around 2-3 seconds) followed by the depletion of PC (which takes around 10 seconds).
For the aerobic system, fuel depletion generally refers to the depletion of glycogen stores. Once these stores are depleted, which generally occurs after 2-3 hours of physical activity, then the body will switch over to fats as the major producer of ATP, and exercise intensity will decrease.

Accumulation of Metabolic By-Products

The build-up of metabolic by-products is a source of fatigue for the two anaerobic energy systems. Increased *ADP* and *inorganic phosphate (Pi)* levels, which are caused by the breakdown of ATP, reduces muscle contraction force, therefore causing fatigue.

Elevated Body Temperature

When our core body temperature starts to overheat during physical activity, more blood is sent to the skin in an effort to cool the body down. This results in less blood (and therefore less oxygen and fuels) flowing to the working muscles, resulting in fatigue.

Energy Systems

Energy System	Likely Cause of Fatigue
ATP-PC System	Fuel Depletion: - Stored ATP - PC
Anaerobic Glycolysis System	Accumulation of Metabolic By-Products: - H^+ Ions (this is the key one) - Inorganic Phosphate - ADP
Aerobic System	Fuel Depletion: - Glycogen - Fats Elevated Body Temperature

Energy System	Recovery Type
ATP-PC System	Passive
Anaerobic Glycolysis System	Active
Aerobic Glycolysis System	Active

Passive recoveries are best for replenishing PC stores.

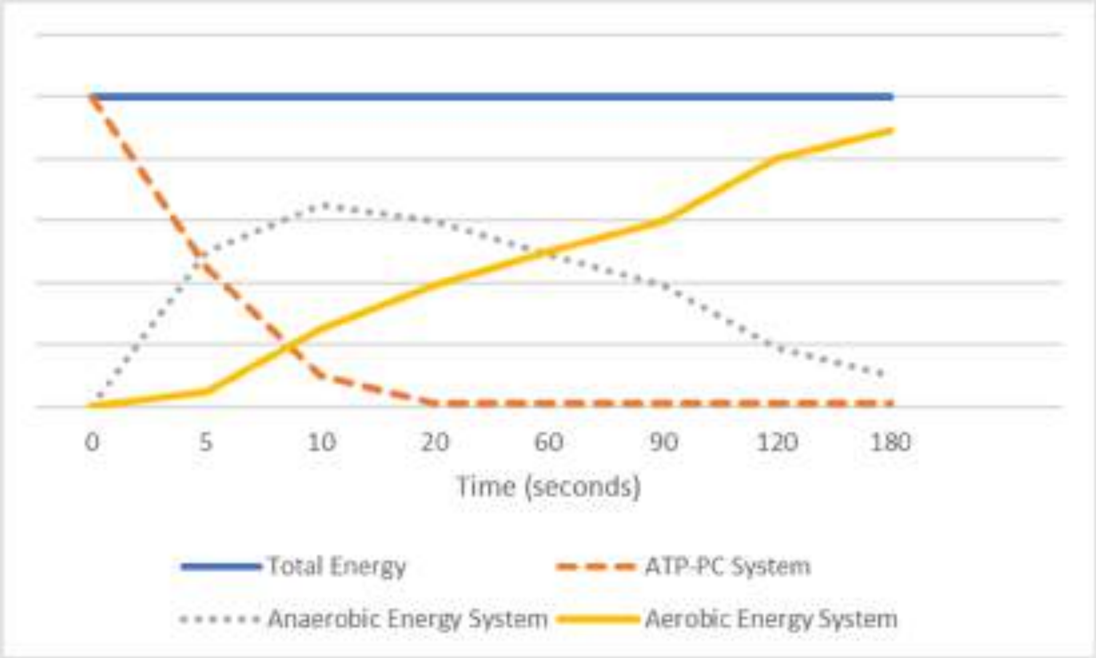
Active recoveries are best for the removal of metabolic by-products and ensuring oxygen and fuels continue to flow to the muscle.

Energy Systems

- *Interplay of energy systems in relation to the intensity, duration and type of activity (VCAA 2017)*

Energy System Interplay

The three energy systems don't function in an 'on/off' way. Each energy system is always contributing to the rebuilding of ATP, until it is depleted. The contribution of each energy system varies, depending on the duration and the intensity of the physical activity.



Example only, not exact figures

Energy Systems

SAMPLE QUESTION: 'Volleyball is a team sport and a match generally takes between 30 and 60 minutes. Players are involved in high-intensity, short-duration movements, such as serving, passing, setting, spiking and blocking. The game is explosive in nature with rest periods between points.
Using the information provided, describe the interplay of the three energy systems in volleyball' (VCAA, 2014 exam).

<u>All three energy systems would contribute to the ATP production of a player throughout the game. Their contributions will vary depending on the intensity and duration of the activity.</u> During high-intensity activities such as spiking and blocking, the ATP-PC system would be the predominant system due to its ability to produce ATP at a rapid rate. Between points, when intensity is low, the aerobic glycolysis system would be the dominant system as the demand for ATP is not as high. During this time, the ATP-PC system can also be replenished, allowing it to be used during the next point. The anaerobic glycolysis system will be used during extended rallies of high intensity, when a player may have to perform multiple spikes or blocks and their ATP-PC system becomes exhausted. As the match lasts 30-60 minutes, the aerobic glycolysis system would be used predominantly.

Energy Systems

Note you still do have to think about these questions logically.

For example, during the final sprint of a marathon, the anaerobic glycolysis system will increase its contribution, as the intensity has been increased. However, the aerobic system is still likely to be the energy system making the greatest contribution.

SAMPLE QUESTION: 'Volleyball is a team sport and a match generally takes between 30 and 60 minutes. Players are involved in high-intensity, short-duration movements, such as serving, passing, setting, spiking and blocking. The game is explosive in nature with rest periods between points.
Using the information provided, describe the interplay of the three energy systems in volleyball' (VCAA, 2014 exam).

Energy Systems

- Know what fuels are used by each system, how they are stored, and common foods they are found in
- Know how each energy system produces energy from ATP (diagrams) – I found this just really helps to wrap your head around everything
- Practice energy interplay questions (have a good first sentence or two written down). Always use examples from the question.
- Have a good understanding of when different energy systems are used (know predominant events)
- Remember that, unless they are exhausted, all three energy systems are always making a contribution to energy production. It is not a 'one at a time' approach.

Acute Responses

- *Oxygen uptake at rest, and during exercise and recovery, including oxygen deficit, steady state, and excess post-exercise oxygen consumption (VCAA 2017)*

Oxygen Deficit

When we begin exercise, there is a period of time when the oxygen demand from the body exceeds oxygen supply. During this time, the body has to rely more on the two anaerobic energy systems to supply the necessary ATP.

Steady State

Steady state occurs when oxygen supply is equal to oxygen demand. During steady state, heart rate will remain constant.

Oxygen Debt (EPOC)

Oxygen debt, or excessive post-exercise oxygen consumption (EPOC), occurs after exercise.

During EPOC, PC and ATP stores are restored at the muscle, H^+ ions are removed from the body, core body temperature is reduced and lactic acid is broken down.

Acute Responses

VO_2 Max

VO_2 max is the maximum amount of oxygen that a person can take in and use per minute. It can be calculated using the following formula:

$$VO_2 \max = Stroke\,Volume \times Heart\,Rate \times a - VO_2\,Difference$$

It is possible for someone to work 'above' their VO_2 max. For this to happen, some of their energy is being produced by the anaerobic energy systems.

Acute Responses

- *Acute physiological responses to exercise in the cardiovascular, respiratory and muscular systems (VCAA 2017)*

Acute Responses

When a person begins exercise, the body makes a number of changes. These changes are known as 'acute responses', and only last for the duration of the exercise and the immediate recovery period.

A key understanding is that muscles need oxygen to work. The harder the physical activity, the more oxygen they need.

Nearly all of these responses aim to increase the amount of oxygen that can be supplied to the working muscles for the duration of the physical activity. This is really important as more oxygen means that more ATP can be produced using the aerobic energy system, which produces a greater amount of ATP than the anaerobic energy systems and causes far less fatigue.

Acute Responses

Respiratory Acute Responses

- Increased Respiratory Rate
- Increased Tidal Volume
- Tidal Volume plateaus at a high (but not maximal) intensity.
- Increased Ventilation
- Increased Pulmonary Diffusion

Acute Responses

Cardiovascular Acute Responses

- Increased Heart Rate.

Max heart rate = 220 – Age.

- Increased Stroke Volume

- Increased Cardiac Output

- Increased Blood Pressure

Exercise results in an increase in systolic blood pressure, which is the pressure is the pressure in the arteries after the blood has been pumped out of the heart.

- Blood Redistribution

During physical activity, blood is redirected from elsewhere in the body towards the working muscles.

Acute Responses

Cardiovascular Acute Responses (cont.)

- Increased Venous Return

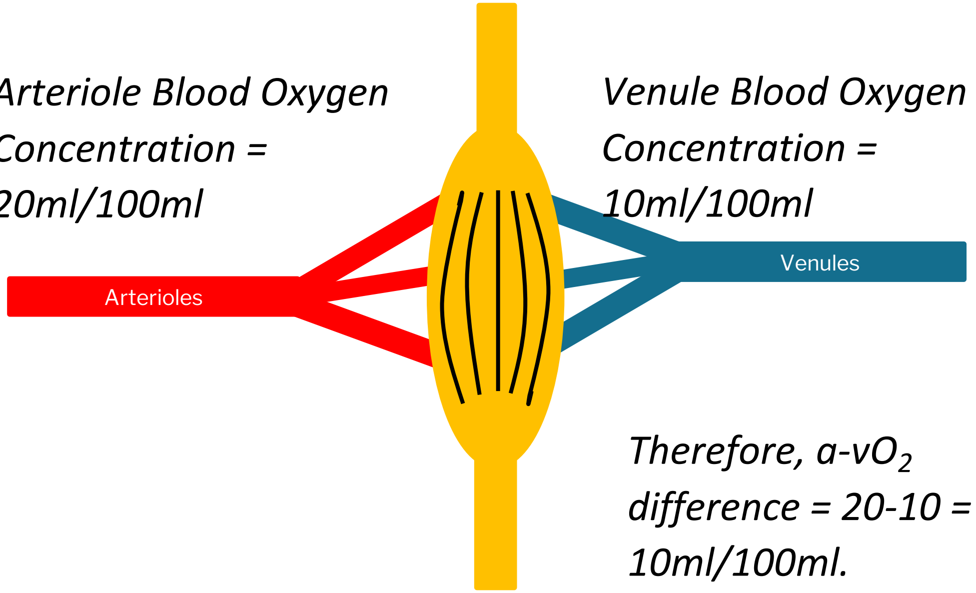
Venous return is increased via vasoconstriction, the muscle pump (when muscles contract, squishing veins) and the respiratory pump (when the diaphragm increases pressure).

- Decreased Blood Volume
- Increased a-vO_2 difference

Arteriole-Venule Oxygen Difference (known as a-vO_2 difference or a-vO_2 diff) is the difference in the concentration of oxygen in the arterioles (which transport blood **to** the muscle) compared to the venules (which transport blood **away** from the muscle). It shows how much oxygen is actually being used by the muscles. When the body is performing physical activity, a-vO_2 difference will increase as the muscle will be using more oxygen.

Arteriole Blood Oxygen Concentration = 20ml/100ml

Venule Blood Oxygen Concentration = 10ml/100ml



Therefore, a-vO_2 difference = 20-10 = 10ml/100ml.

Acute Responses

Muscular Acute Responses

- Increased Motor Unit Recruitment and Activation
- Increased Temperature
- Increased Production of By-Products
- Decreased Energy Substrate (Fuel) Levels

Acute Responses

- Steady state = oxygen supply is equal to oxygen demand, and therefore heart rate will remain constant
- Easy acute responses to remember (if you're struggling) are increased Heart Rate, Stroke Volume and Cardiac Output (cardiovascular). Also increased Respiratory Rate, Tidal Volume and Ventilation (respiratory).
- Know the difference between acute responses and chronic adaptations (covered in Unit 4 – long-term changes to the body)
- Generally, nearly all acute responses aim to increase oxygen supply to the working muscles
- Generally, I would recommend (as a minimum) knowing a couple really well, and then having a rough idea of all of the others

Activity Analysis & Fitness Components

- *Activity analysis, including skill frequencies, movement patterns, heart rates and work to rest ratios* (VCAA, 2017)

An **activity analysis** is always the first step of designing a training program! It should guide the design of the training program by identifying the major fitness requirements, fitness components and skills needed in the sport.

In an activity analysis, information collected includes:

- Skill Frequencies
- Movement Patterns
- Heart Rates
- Work to Rest Ratios

Activity Analysis & Fitness Components

- *Fitness components: definitions and factors affecting aerobic power, agility, anaerobic capacity, balance, body composition, coordination, flexibility, muscular endurance, power and strength, reaction time and speed* (VCAA, 2017)

Aerobic Power

Definition: The maximum rate of energy production from the aerobic energy system (i.e. energy produced in the presence of oxygen).

Factors Affecting:

- Cardiac output
- Number or size of mitochondria (where ATP is produced)
- Age (peaks around 25-28 years old)
- Gender (males have higher due to larger heart and lungs)

Anaerobic Capacity

Definition: The total amount of work that can be done using the two anaerobic energy systems.

Factors Affecting:

- Gender (males tend to have a greater anaerobic capacity due to increased muscle mass and number of fast-twitch fibres)
- Type of Muscle Fibres (proportion of fast-twitch fibres to slow-twitch)

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Activity Analysis & Fitness Components

Body Composition

Definition: The proportion of fat-free mass compared to fat mass.

Factors Affecting:

- Gender (females tend to have a slightly higher percentage of body fat than males)

Muscular Endurance

Definition: The ability of muscles to perform repeated contractions over a long period of time.

Factors Affecting:

- Fibre Type (slow-twitch muscle fibres more suited to repeated contractions)
- Fatigue (high levels of fatigue will reduce muscular endurance)

Activity Analysis & Fitness Components

Flexibility

Definition: The ability of a joint to move through its entire range of motion.

Factors Affecting:

- Age (flexibility levels decrease with age)
- Gender (females more flexible than males)
- Joint Structure (different types of joints allow for different amounts of movement)

Balance

Definition: Being able to maintain equilibrium whilst either stationary or moving.

Factors Affecting:

- Change in Location or Body Position (can upset the equilibrium of the body)
- Centre of Gravity (a lower centre of gravity leads to better balance)

Activity Analysis & Fitness Components

Muscular Strength

Definition: The maximum force that can be produced by a muscle in one effort.

Factors Affecting:

- Area of Muscle (greater area gives greater potential muscle force)
- Contraction Type (isometric, concentric, eccentric, isokinetic)
- Speed of Contraction (faster contraction equals less load on the muscle)

Agility

Definition: The ability to change direction in a fast and accurate manner.

Factors Affecting:

- Reaction Time (faster reaction allows people to move faster)
- Cognitive Ability (agility generally occurs in response to a stimulus, such as a tennis shot or an oncoming tackler in football. Being able to recognise this stimulus is an important part of agility)

Activity Analysis & Fitness Components

Coordination

Definition: The ability to perform motor skills smoothly, efficiently and accurately.

Factors Affecting:

- Practice (coordination is simply improved through practice)

Muscular Power

Definition: The rapid exertion of a force over a quick period of time.

Factors Affecting:

- Speed of Contraction (muscular power increases with contraction speed up until a certain point, then slightly decreases at maximum contraction speed)
- Muscle Size (bigger muscle equals more potential power)
- Fibre Type (fast-twitch fibres have greater potential power)

Activity Analysis & Fitness Components

Reaction Time

Definition: The time taken for the body to react to a stimulus.

Factors Affecting:

- Number of Stimuli (the more stimuli there are, the slower that reaction time tends to be)

Speed

Definition: How fast the body or a body part can be moved from one place to another

Factors Affecting:

- Number of Muscle Motor Units Recruited (more motor units equals increased force and therefore increased speed)
- Fibre Type (fast-twitch fibres contract more quickly than slow-twitch)

Activity Analysis & Fitness Components

For each of the fitness components, know:

- Definition of the component (doesn’t have to be word for word – but learn one before the exam)
- Factors affecting the component. Easy ones to remember are age and gender.
- Activity analysis probably won’t be a major part of the exam. However, don’t forget about it! It is always the first step of designing a training program!

Training Methods & Principles

- *Strategies to monitor and record physiological, psychological and sociological training data, including training diaries, digital activity trackers and apps (VCAA, 2017)*

Training diaries can be used to record information about training sessions, such as what activities were completed (e.g. times, reps etc.), which can be useful to track progress. This information can also be recorded by **digital activity trackers** such as Fitbits and Garmin's, and can be logged on an app for later access.

As well as physiological data, psychological and sociological data should also be taken, as this can help to measure motivation levels and also provide some context to the numerical data (e.g. it was really hot today so I only did a short session).

Training Methods & Principles

- *Components of an exercise training session including warm up, conditioning phase and cool down (VCAA, 2017)*

Warm Up
Prepares the body and mind for the upcoming session. Increases muscle temperature, breathing and heart rate, and generally just helps 'loosen up'. Often includes gradual aerobic exercise (e.g. jogging a lap) and some dynamic stretching.

Conditioning
This is the main component of the session. Intensity and volume of training will vary depending on what sport is being trained for (specificity is important here). This is where training principles and methods are important.

Cool Down
Aims to return the body to pre-exercise levels. Attempts to remove waste products from muscles, helping to reduce DOMS, and reduce heart and breathing rate. Often similar activities that were performed in the conditioning phase will be performed, but at a lower intensity, and static stretching may be used to decrease muscle stiffness.

Training Methods & Principles

- *Training program principles, including frequency, intensity, time, type, progression, specificity, individuality,*

diminishing returns, variety, maintenance, overtraining and detraining (VCAA, 2017)

Frequency

How often training sessions occur. For significant improvements to be made, training must occur at least three times per week.

Intensity

Training Zone	Energy System	% of Max HR	% of VO_2 Max	Important Benefits
Recovery	Aerobic system	Less than 70	Less than 50	N/A
Aerobic	Aerobic system	70-85	55-75	Trains aerobic system and aerobic capacity
Lactate Inflection Point (LIP)	Aerobic system	80-90*	70-80*	Increases LIP
Anaerobic	Anaerobic glycolysis ATP-PC	85-95 95+	75-85 100+	Increases anaerobic capacity and lactate tolerance

Training Methods & Principles

Intensity (cont.)
There is a difference between lactate inflection point (LIP) and lactate tolerance, and it is super important.

Lactate inflection point (LIP) is the last point where lactate entry into and removal from the blood are balanced When this is increased, a person can work at a higher intensity while still producing ATP aerobically, meaning less fatigue. This is trained aerobically.

Lactate tolerance is a person's ability to keep working at a high intensity despite the build-up of lactate, and the associated feelings of fatigue. (Remember, lactate doesn't cause fatigue). This is trained anaerobically.

Time/Duration
Duration can refer to either the length of a training session or the length of an overall training program. Continuous training sessions should last for at least 20 minutes.

Type
Type refers to whether the training is aerobic or anerobic, which is largely determined by the training method used.

Training Methods & Principles

Progression (Overload)

Progression refers to increasing training difficulty to ensure that fitness improvements continue to occur.

<u>The golden rule with overload is never to overload by more than 10%.</u>

Also, only one variable (e.g. number of reps) should be overloaded at any one time.

Specificity

Specificity refers to making the training program as similar as possible to the sport that you are training for.

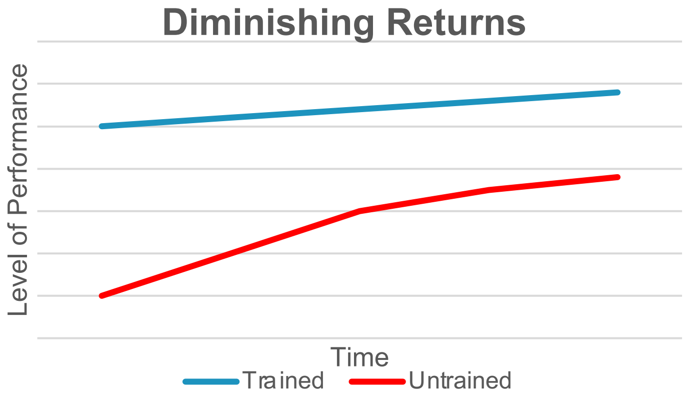
This includes things such as major movements, fitness components, energy systems, W:R ratios and intensity levels.

This is also why an activity analysis is essential.

Training Methods & Principles

Individuality
Individuality is about tailoring training programs to the individual.
E.g. A person with more slow-twitch muscle fibres will respond better to aerobic training.
Can also take into account fitness levels and injuries.

Diminishing Returns
As people get fitter, their fitness improvements tend to occur more slowly. Untrained individuals will show more rapid improvement when they undertake a training program than a trained individual completing the same program. However, the trained individual will still usually perform at a higher level.



Variety
Variety during training sessions is important to ensure that the athlete remains interested and motivated. Variety can often clash with specificity. It is important to remember that while varying exercises can be a good idea, they should still replicate the demands of the sport.

Training Methods & Principles

Maintenance

Maintenance refers to 'holding on to' or keeping fitness gains that occurred during an intense period of training. To maintain (but not improve) fitness, training can occur twice per week.

Overtraining

This occurs when an athlete trains too much and doesn't give themselves sufficient recovery time. This can cause long-term decreases in performance levels, and is a key reason why it is important to include rest days in a training program.

Detraining

Detraining, also known as reversibility, refers to the potential loss of fitness that was gained during a training program. If training is completely stopped, a loss of previously achieved fitness gains will occur. In around three weeks of no training, both cardiac output and VO_2 max can decrease by up to 8%, while after 12 weeks of no training, VO_2 max can drop by as much as 18%.

Training Methods & Principles

- *Training methods including continuous, interval (short, intermediate, long and high intensity), fartlek, circuit, weight/resistance, flexibility and plyometrics (VCAA, 2017)*

Continuous Training

Continuous training involves performing an activity such as running or bike riding nonstop for a long period of time (should be at least 20-30 minutes). This targets the aerobic energy system and should be performed in the aerobic training zone, which is between 70-85% of maximum heart rate. Continuous training has a number of health-related benefits and also has low injury rates.

Fartlek Training

Fartlek training involves continuous running (jogging) with high-intensity bursts of random length (key difference from interval training). Therefore, it can target both the aerobic and anaerobic energy systems.

Circuit Training

Circuit training involves performing different activities at different 'stations' of a circuit. Circuit training can be very useful to target a number of different fitness components during one session. However, the improvement of these components will always be less than if they were trained exclusively during a session. Circuits can be a great way to add variety and can easily be overloaded.

Training Methods & Principles

Interval Training
During interval training, periods of high-intensity are interspersed with periods of rest. The length of the work and rest periods can be changed to target different energy systems and fitness components.

Short-Interval Training – The work period is under 10 seconds in length, and the W:R ratio should be about 1:6. The ATP-PC system is the dominant system.

Medium-Interval Training – The work period is between 10 and 60 seconds in length and the W:R ratio should be around 1:2 or 1:3. Medium-interval training targets the anaerobic glycolysis system. Can build lactate tolerance.

Long-Interval Training – Involves a work period of at least one minute and a W:R ratio of 1:1 or more. The aerobic system is the predominant system being trained. Can increase LIP.

High-Intensity Interval Training (HIIT) – A relatively new training method that involves periods of short, high-intensity work (roughly 10-30 seonds) followed by periods of reduced intensity recovery. This targets the aerobic system, and results in aerobic chronic adaptations. An advantage of this over other traditional aerobic training methods (e.g. continuous) is that it can take less time to perform.

Training Methods & Principles

Resistance Training (Weights)

Resistance training increases muscular strength, which can also increase muscular power and speed. However, it can have a high risk of injury, particularly if not performed correctly.

Component/Outcome	Repetition weight (% of max rep)	Number of reps	Number of sets	Repetition speed
Muscular Strength	60-70	8-12	1-3	Slow to Moderate
Muscular Hypertrophy	70-85	8-12	1-3	Slow to Moderate
Muscular Power	30-60	3-6	1-3	Fast
Muscular Endurance	40-60	15-25	1-3	Slow to Moderate

Plyometric Training

Plyometric training focuses on developing muscular power. Plyometric training generally involves standing jumps. It uses something known as the stretch reflex, which is when the body initiates a eccentric contraction before a rapid concentric contraction to prevent overstretching of the muscles. A clear example of this is how we bend at the knees and hips before jumping vertically. Clear safety guidelines should be followed.

Training Methods & Principles

Flexibility Training

Increased flexibility can lead to increased performance levels through allowing for increased speed, strength and power. It can also reduce the chances of injury and reduce stress.

Flexibility is improved through stretching. There are four different types of stretches:

Static Stretching

Dynamic Stretching

Ballistic Stretching – Is the same as dynamic stretching but with much greater force, and therefore there is a much higher chance of injury. Uses the momentum of a moving body part to produce the stretch. Should only be performed in very few circumstances and not advisable in general for athletes.

Proprioceptive Neuromuscular Facilitation (PNF) Stretching – The participant moves the muscle through its range of motion until discomfort is felt, then the muscle is contracted isometrically (no change in length) for six seconds. The muscle is then slightly relaxed before being stretched isometrically for another six seconds.

Training Methods & Principles

- Know which energy systems and fitness components each training methods predominantly trains
- Know a couple of advantages of each type of training
- Be able to identify training principles that have been incorporated correctly/incorrectly into a training program – pick the easy ones!!
- Know about specificity and how to explain it *e.g. the training for football should replicate the major movements, muscle groups and energy systems used during a match of football, and be performed at appropriate intensities. For example, if training to be a full-forward, short, high-intensity bursts of training, such as short sprints, should be performed to replicate leading for a mark.*
- Be able to write how overload could be applied to a specific program. Keep it simple (e.g. increase duration of run). Remember, never overload by more than 10%.
- Remember high-intensity interval training (HIIT) is an aerobic training method that leads to aerobic chronic adaptations, such as an increased LIP

Chronic Adaptations

- *Chronic adaptations of the cardiovascular, respiratory and muscular systems to aerobic, anaerobic and resistance training (VCAA, 2017)*

Chronic adaptations are long-term changes that happen to your body as a result of consistent and sustained training.

They are different from acute responses as acute responses only last for the duration of the exercise and the immediate recovery period. Chronic adaptations are long-term changes.

Chronic adaptations can occur from both aerobic and anaerobic training, and occur in three main bodily systems – the cardiovascular, respiratory and muscular.

IMPORTANT: *Many of these aerobic chronic adaptations allow for more oxygen to be delivered to the working muscles. This is extremely important as it allows ATP to be produced aerobically. The aerobic energy system produces far more ATP than the anaerobic energy systems and also doesn't produce any fatigue-causing by-products. Therefore, when energy is able to be produced aerobically, performance is increased. This is a key understanding and is how I tend to think of nearly all the aerobic chronic adaptations.*

Chronic Adaptations

Aerobic Cardiovascular System Adaptations

- Increase in Left Ventricle Size

- Increase in Stroke Volume

- Increase in Maximum Cardiac Output

At rest or during submaximal physical activity, cardiac output may actually slightly decrease following sustained aerobic training.

- Decrease in Heart Rate

Max heart rate remains the same.

Chronic Adaptations

Aerobic Cardiovascular System Adaptations (cont.)

- Increase in Capillary Density around the Heart and Muscles
- Increase in Blood Volume
- Increase in Haemoglobin Levels
- Decrease in Blood Pressure

At maximal exercise, blood pressure will not change.

- Decrease in Myocardium (Heart Muscle) Oxygen Consumption

Chronic Adaptations

Aerobic Cardiovascular System Adaptations (cont.)

- Change in Blood Flow to Muscles

During rest and submaximal physical activity, a chronic adaptation to aerobic training is that <u>less</u> blood actually flows to working muscles due to their increased efficiency in using oxygen. This means that more blood is available to flow to the skin and other places to assist with processes such as cooling. During maximal exercise, more blood will be able to flow to working muscles due to increased cardiac output and increased blood volume.

- Increase in Removal of Blood Lactate

Increased levels of oxygen to the muscles mean that lactate (and H^+ ions) is able to be removed from the muscles more efficiently. This reduces fatigue levels and increases an athlete's Lactate Inflection Point (LIP). <u>This is essential as it allows an athlete to work at a higher intensity and yet not suffer fatigue due to a build-up of H^+ ions.</u>

- Increase in Venous Return

Chronic Adaptations

Aerobic Respiratory System Adaptations

- Increased Lung Volume
- Increased Tidal Volume
- Increase in Maximum Ventilation

At submaximal level of physical activity, ventilation levels will slightly decrease.

- Increase in Pulmonary Diffusion
- Increase in Ventilatory Efficiency
- Increase in VO_2 Maximum

Chronic Adaptations

Aerobic Muscular System Adaptations

- Increased Aerobic Capacity of Muscle Fibres
- Increased Size of Slow-Twitch Fibres
- Increase in Myoglobin
- Increase in Number and Size of Mitochondria
- Increased Oxidative Enzymes
- Increase in Triglyceride and Glycogen Stores

Chronic Adaptations

Anaerobic Cardiovascular System Adaptations

- Increase in Thickness of Left Ventricle Wall
- Reduced Blood Pressure at Rest and During Submaximal Activity

Anaerobic Muscular System Adaptations

- Increased Fuel Stores
- Increased Levels of ATPase and Glycotic Enzymes
- Increased Tolerance to Metabolic By-Products

Chronic Adaptations

Anaerobic Muscular System Adaptations (specifically from resistance training)

- Increased Motor Unit Recruitment
- Increased Rate of Motor Unit ‘Firing’
- Increase in Motor Unit Coordination
- Hypertrophy of Muscles

Chronic Adaptations

- Likely to be a question on LIP/lactate tolerance – so know the difference!

- Know how to explain how each chronic adaptation leads to increased performance. Aerobic adaptations are generally all about getting more oxygen to the working muscles, allowing more energy to be produced aerobically.

- Know at least a couple of adaptations from each category (e.g. aerobic, anaerobic, cardiovascular, respiratory, muscular) and how to explain them in detail.

Psychological & Nutritional Strategies

- *Psychological strategies used to enhance performance and aid recovery including sleep, confidence and motivation, optimal arousal, mental imagery and concentration (VCAA, 2017)*

Sleep
A lack of sleep can decrease performance, as it can lead to decreased endurance, impaired decision-making ability, decreased tissue repair and decreased ability to break down glucose, among other things.

Confidence and Motivation
Confidence is important - people who are self-confident are less likely to give up and more likely to be emotionally stable under pressure. However, over-confidence (arrogance) can result in decreased performance levels.

Motivation is also really important – a more motivated person is more likely to train and complete tasks. *Intrinsic motivation* is motivating factors internal to the athlete, whilst *extrinsic motivation* are motivating factors external to the athlete. Positive motivation (praise) should be used with beginners, rather than negative motivation (criticism).

Goal setting is another good way to increase motivation.

Psychological & Nutritional Strategies

Optimal Arousal

Arousal is how ready a person is to perform an action/task. Arousal levels and performance levels have an 'inverted U' relationship.

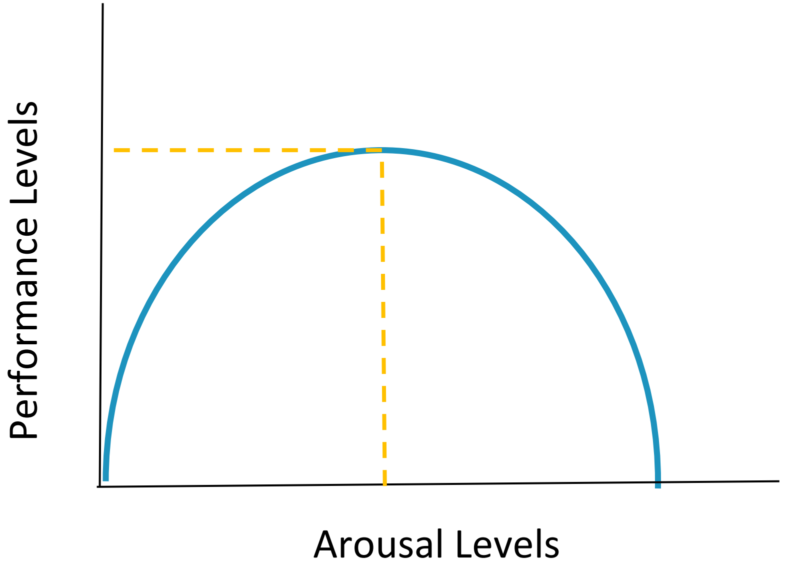
Low arousal (boredom) can lead to a lack of motivation, perceived fatigue and overall lower performance levels. High arousal (anxiousness) can lead to muscle tension and therefore decreased coordination and performance. Optimal performance levels occur at optimal arousal levels. It is important that before physical activity or competition, arousal levels are managed effectively. Different sports will require different levels of arousal for optimal performance!

Increasing Arousal Levels

- *Increasing Breathing Rate*
- *Acting Energetically* – May include a warm-up

Reducing Arousal Levels

- *Reducing Breathing Rate*
- *Progressive Muscle Relaxation (PMR)*
- *Meditation*



Psychological & Nutritional Strategies

Mental Imagery

Mental imagery involves the individual imagining themselves performing the task before actually doing it. The use of mental imagery can actually strengthen the coordination of their muscles. Mental imagery is only effective if the individual is relaxed at the time and visualise themselves succeeding at the task. Mental imagery can improve performance by strengthening the connections between the brain and the muscles and allowing athletes to identify potential problems with their approach or technique.

Concentration

Concentration is the ability to focus on relevant things over an extended period of time. Concentration can be broken down into four types:

Broad-Internal – Focusing on own thoughts and feelings (e.g. a sprinter about to start a race)

Narrow-Internal – Used to mentally rehearse upcoming movements and shut out irrelevant feelings and thoughts (e.g. used by gymnasts and divers just before they perform their movement)

Broad-External – Focusing on the actions of others (e.g. watching a soccer player try to make a dash behind the defence)

Narrow-External – Focusing on one particular thing that is external to your own thoughts and feelings (e.g. watching a cricket ball come down the pitch towards you as a batsman)

Psychological & Nutritional Strategies

- *Nutritional and rehydration recovery strategies including water, carbohydrate and protein replenishment (VCAA, 2017)*

Water

Water is a key way to replace fluids lost as sweat during exercise. However, most athletes use sports drinks, as well as water, to not only rehydrate but also help to replace electrolytes and carbohydrates lost during physical activity. *Hypertonic sports drinks*, which have a high concentration of electrolytes, are often consumed after physical activity as part of the refuelling process.

Carbohydrate Replenishment

It is essential that after physical activity, carbohydrate stores are replenished as soon as possible, as the muscle is much more receptive to fuels soon after physical activity. High-GI foods, which raise blood sugar extremely quickly, should be consumed immediately after physical activity. *Carb loading* can be used pre-exercise to increase carbohydrate stores in the body, allowing them to be used as the main fuel source for longer periods of time.

Protein Replenishment

Similar to with carbs, to allows muscles to properly build and repair, foods that are high in protein should be eaten immediately after exercise, particularly if resistance training was used.

Tips & Advice

Thank you for coming!

Good luck for the year!

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